GENERAL NOTES.

BOTANY.[1]

VEGETABLE DIGESTION.[2] The following note is an abstract of Professor Morren's communication: —

There is no doubt that certain plants have the power to allure, retain, kill, dissolve, and absorb insects and even larger animals. There is nothing astonishing in this, for to my mind the facts observed among the carnivorous plants are in perfect harmony with the general theory of the nutrition of plants.

Digestion is not the exclusive characteristic of carnivorous plants, but is common to all living beings, animal as well as vegetable. In animals, digestion in its essence is considered by chemists to be an indirect fermentation, consisting of an hydration, followed by a splitting up into new and more simple forms of the digestible materials. These marvelous and necessary transformations are accomplished by the action of mysterious and powerful substances called ferments. The ferments are derived, according to all appearances, from the albuminous matters, and seem to be a part of the protoplasm itself. They are more or less distributed throughout all the animal organism, but particularly abundant in the juices which are secreted especially in view of digestion, such as the saliva, gastric, pancreatic, and intestinal juices. They may be extracted in a separate form and their activity still be preserved.

The food, as it is taken in by the animal, is not usually in a state fitted to pass into the system, and these ferments act upon it and produce the necessary changes, the albuminoids pass into "peptones," starch into sugar, fats into an emulsion, each class of foods being transformed by its own appropriate ferment.

Plants also take in their food in a crude state, and digestion is as essential with them as with animals. The ferments form an integral part of the vegetable organism, and are even more numerous in the vegetable than the animal kingdom.

Diastase or *glycosic ferment.* This is the digestive ferment of amylaceous substances. By its influence starch is hydrated and divided into the readily soluble products, dextrine and glucose —

$$2(C_6H_{10}O_5) + H_2O = C_6H_{10}O_5 + C_6H_{12}O_6$$

$$\text{Starch} + \text{water} = \text{dextrine} + \text{glucose.}$$

In animals these changes are brought about by the saliva and pancreatic juice. A fine illustration of this action among vegetables is seen in the germination of masses of barley, or malting as it is commonly termed.

[1] Conducted by PROF. G. L. GOODALE.

[2] *La Digestion Vegetale,* note sur le rôle des ferments dans la nutrition des plantes, communiquée a l'Académie Royal de Belgique dans sa séance du 21 Octobre, 1876. Par M. EDOUARD MORREN, Professor a l'Université de Liége.

This action of diastase probably takes place when any reservoir of starch is used by a plant for purposes of growth. "We are not to occupy ourselves here with the nature and origin of diastase, still less with its action. . . . . Suffice it to state for the present that chemists establish no distinction between the animal and vegetable diastase, of which the power is the same and the rôle identical."

"*Ferment inversif.*" Saccharose, like starch, is a ternary compound accumulating in certain tissues in view for its need in nutrition, as in the stem of the sugar-cane, or root of the sugar beet. Though soluble it is not assimilated as such by animals, but is split up by this transposing ferment into glucose and levulose or transposed sugar.

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$$

$$\text{Saccharose} + \text{water} = \text{glucose} + \text{levulose}.$$

These changes are seen on a grand scale in the beet root during the flowering of that plant.

Emulsive and *saponaceous ferment.* The fat bodies are digested in the intestines of animals by means of pancreatic juice by first making them into a fine mechanical mixture followed by a somewhat complicated chemical change called saponification, or hydration and division into glycerine and fatty acids. For example: —

$$C_3H_5(C_{18}H_{33}O.O)^3 + 3H_2O = C_3H_8O_3 + 3(C_{18}H_{33}O.HO)$$

$$\text{Trioleine} + \text{water} = \text{glycerine} + \text{oleic acid}.$$

This same ferment exists in vegetables. Oleaginous seeds when ground up in water form an emulsion, and if allowed to stand for a time glycerine and fatty acid are produced. There is no doubt that the oils and fats in vegetables constitute a nutritive provision, as the grains of Crucifers, Linum, and bulbs of the Onion will show.

Albuminous ferment; pepsine. We come now to the digestion of nitrogenous substances under the influence of the pepsine of the gastric juice. Mr. Darwin, as his work on Insectivorous Plants will show, believes there is no doubt but that plants have this same power, and quotes M. Frankland's experiments, in which he found pepsine in the glands of the Drosera. More recently MM. Max Rees and H. Will (Bot. Zeit. 29 Oct., 1875), have extracted this ferment by the usual process, and with it they have caused artificial digestion of fibrine. It is in the grains that there is most frequently found a considerable quantity of albuminoids stored up as gluten, legumin, and aleurone to serve the requirements of the germinating plantlet. These substances are usually in an insoluble state, but are dissolved as required. The ferment doing this valuable work of solution is not thoroughly understood. MM. Gorup-Besanez and H. Will (Bericht der Deutsch. Chem. Gesells., Berlin, 1874, p. 1478) state that the seeds of *Vicia sativa* contain with starch a notable proportion of legumin, and when these seeds germinate the legumin disappears, and *leucine* and *asparagine* are produced; and they presume these bodies result from a division produced by a

ferment residing in the seed. The grains of Vicia were treated first for forty-eight hours with alcohol and afterwards with glycerine. Drops of such solutions were placed on starch of which notable quantities were changed into sugar, while similar liquids in which seeds had not been digested produced no change. It is safe to conclude that the existence of a pepsine ferment is established in the vegetable kingdom. Thus we have established among plants the digestion of starch, sugar, oils, and albuminoids, precisely the four normal kinds of digestion in man and animals. But we find still other and often very complicated vegetable ferments, such as the *myrosine* causing the mustard fermentation, and *pectose* of the pectic fermentation.

The similarity of composition of milk and endosperm, or in other words the food of the young animal, and young plant, has long been noticed. As an illustration we give the following: —

WHEAT FLOUR (DRY).			COW'S MILK (DRY).		
Starch	780	800	Sugar of milk	347	605
Fatty matters	20		Butter	258	
Gluten	170	190	Caseine	242	339
Albumen	20		Albumen	95	
Salt		10	Salt		56
		1000			1000

Both contain two ternary and two nitrogenous ingredients. During germination the endosperm undergoes nearly the same changes as the milk in the digestive system of the animal. The digestive power of vegetation appears very evident if we consider those plants destitute of chlorophyll. Thus the Bactaria and similar plants are representatives of fermentation. But the majority of plants have chlorophyll, and their activity differs from those without it, by their absorbing carbonic dioxide and elaborating their own food.

To consider only the phenomena which interests us at this moment, one recognizes three very distinct and consecutive functions, namely, *elaboration, digestion,* and *assimilation.*

Elaboration has for its part the production of carbohydrates out of carbon dioxide and water. It is characteristic of chlorophyll, and takes place in sunlight, the type of its products being starch ($C_6H_{10}O_5$).

Digestion takes place in protoplasm in the presence of oxygen with a production of carbonic dioxide. It consists in a hydration not accompanied by a molecular change, by which the elaborated matter is dissolved and diffused, starch passing into glucose ($C_6H_{12}O_6$).

Assimilation is the fixing of these digested materials into the texture of the plant, the glucose passes into permanent cellulose ($C_6H_{10}O_5$).

All these processes may be confined to a single cell, as in many unicellular plants, while in the higher forms the labor is much divided.

Protoplasm includes the sum total of vegetable activity. The cells remain active during a definite time, that is to say, while their protoplasm continues to live in the shelter of the protecting membrane which it it-

self has made; finally it abandons the cell to pass to others towards the new centres of activity, but the tissues, organs, members, the organisms thus constructed remain to attest that life has passed that way, that they are the works of the activity of an organism, like the shell abandoned by the mollusk.

Much wrong has been done in contrasting the nutrition of animals with vegetables. They are the same and ought to be studied in a parallel manner. The only difference, to the advantage of vegetables, consists in this, that plants when they have utilized and applied the supplies which they possessed, have the power of taking up inorganic materials and elaborating them into new organic food, but after such elaboration, nutrition accompanied by respiration, circulation, transformation, and assimilation take place as in animals. In effect the plant, wheat, for example, accumulates a supply of nourishment in the grain near the embryo. If this accumulation feeds an animal or nourishes the plant itself, it behaves in the same manner. In the one case it is reduced to a pulp, submitted to the influence of the pancreatic, gastric, and other juices, and is finally absorbed. If the grain is placed under conditions for germination like reduction and transformations are undergone, and the plant is nourished instead of an animal.

The truth of these assertions has been demonstrated by the interesting experiments of M. Ph. Van Tieghem, upon the germination of the *Belle de Nuit* (Recherches Phys. sur la Germination. Ann. des Sc. Nat. 1873.) This able observer has nourished the embryos extracted from the grains and separated from their endosperm by means of paste of the starch of either potato or buckwheat. The grains of starch in contact with the embryo were dissolved, which proves that the necessary ferment resides in the embryo.

Many peculiar organic compounds are common to both forms of life. Formic acid, for example, found among ants, corresponds to that found in many nettles; butyric acid in perspiration to the pulp of tamarinds; palmetic acid in animal fats to the fruit of palm; oxalic acid is quite common to both; and there are numerous other like examples.

Protoplasm of both forms of life are alike, or at least, give the same reactions and have the same movements. The only thing living in a plant is its protoplasm, as it makes the cells and constructs the organism. The same may be said of the animal structure. Thus we are able to infer identity of effect from identity of cause. The unity of structure is the corollary of the unity of nutrition.

To return to carnivorous plants, we are able to recognize that abstraction made on account of their singular structure, enters as a particular case in the general theory. The most interesting thing which they present is the presence of pepsine ferment at their surface in a secreted liquid.

It is well to notice that the facts ascertained among the Droseraceæ, so strange that they have been styled idle stories, have had this happy

result, that they have opened a new horizon upon a simple and general theory.

Professor Morren closes his paper by stating his hope and desire to go still further in this difficult and interesting line of research. — BYRON D. HALSTED, Bussey Institution, March 14, 1877.

ON THE POROSITY OF WOOD. — Professor Sachs has published a preliminary communication in regard to the porosity of wood, which contains notes of many interesting experiments. Two of these will be now briefly noticed. 1. The best grade of artist's vermilion was treated with a large quantity of distilled water and repeatedly filtered through filter-paper. The pigment was now left in so fine a state that it exhibited the well-known Brownian movement. Fresh cylinders of wood three to four cm. long, cut from a living stem of a conifer, were fastened to the lower end of a glass tube which at the upper part communicated with a broad vessel; tube and vessel were filled with the pigment emulsion so that the wood was under a constant hydrostatic pressure of 160 cm. Even at the end of three days the water which filtered through was perfectly clear and contained no trace of the vermilion. The upper transverse sections of the cylinders showed that all the layers of the spring-wood were bright red, the autumn layers were not red at all, or at most only in radial stripes, the heart-wood was wholly uncolored. On splitting the cylinder of wood, the vermilion was seen to have penetrated nowhere deeper than two to three millimeters, corresponding to the length of the cells in the wood employed; the rest of the wood was colorless. The microscope shows that the majority of the spring-wood cells are wholly filled with vermilion even to their lower tips; also that the bordered pits of these cells are thickly filled with vermilion, and sometimes this did not pass through into the neighboring cells which seemed to be in communication with them; there was obviously an obstruction in the bordered pits themselves. This is interpreted as showing that there still remains in the discoid markings, a thin membrane as claimed by Hartig. The autumn wood cells appeared to take up very little vermilion, and the medullary rays none. "These results confirm Hartig's and Sanio's views, that the bordered pits of the spring and a part of the autumn wood are *closed.* Nevertheless there exist at the dividing line between the autumn and spring wood passages which allow air to penetrate." The latter is shown by fastening a three to four cm. cylinder of wood from a living stem, to a bent tube holding mercury and by this means exerting a pressure of fifteen to twenty ct. If the whole is placed under water, the line between the autumnal and the spring wood will be seen to emit a circle of bubbles; but no air bubbles will escape from the first autumnal cells or the last spring cells. This experiment has been tried with the wood of the fir in January, and with *Pinus Laricio*, *Pinus Brutia*, and *Pinus pinsapo* in February. Both fresh and air-dry fir gave

this result; but if the wood is artificially charged with water, no air can be forced through it.

Another portion of the paper refers to the resistance which the walls of wood cells offer to filtration. If distilled water and fresh wood be used, filtration can be conducted with great rapidity. The rate diminishes after a very short time. Professor Sachs has also examined the amount of air in cell-cavities. This amount he has endeavored to determine by a series of calculations, and he gives the following results: —

Fir-stem, 100 cubic centimeters 25 cc. of cell-wall, 58.6 cc. water (in the cell cavities and imbibed by the walls), 16.4 cc. air-space. Geleznow had obtained different results, namely: 100 cc. fresh Betula alba wood contain 32.4 cc. cell-wall, 33.2 cc. water, 34.4 cc. air-space.

It may be said in conclusion that Professor Sachs has found reason for emphasizing the statement in his text-book that a distinction must be made between the passage of water through wood by means of capillarity acting in the capillary cells, and by adhesion to the cell wall. The communication will lead botanists to look with interest for the memoir of which the present short paper is only a forerunner.

ONION SMUT.[1] — Dr. Farlow's essay on this subject is of great value as well to the agriculturist as to botanical science.

The smut plant (*Urocystis Cepulæ*) makes its appearance upon the onion leaves while they are still quite young, often changing the central portion into a mass of black, dusty spores, previous to the formation of which the threads of the fungus have penetrated like a network among the cells of the leaf tissue.

It is peculiar to America, and has probably come from some of our wild species of onion. As a means of checking its ravages, which are now limited to only a few localities, the author suggests as a wise precaution, the destruction of all wild and useless species of onion. Ground on which the smut has appeared should be burned over, and the earlier in the season the better. A knowledge of allied species, supported by a limited experience of the disease in hand, tends to show that the smut spores do not retain their vitality for more than four years; therefore by growing some other crop for a few seasons a partial eradication at least might be expected.

It remains for the suffering onion growers to profit by this excellent instruction, and do all in their power to prevent the spread of the disease into new localities.

With the aid of the plate, in which are figured the plant under consideration, rye smut, and spores of the corn smut, the relations which the onion smut bears to some of the other members of the order *Ustilagineæ* are pointed out. In a note at the close of the paper the new fungus is botanically described. — B. D. H.

[1] *Onion Smut.* An essay presented by DR. W. G. FARLOW, of Harvard University, to the Massachusetts Society for Promoting Agriculture, and published with a plate in their Twenty-fourth Annual Report

SETS OF ALGÆ. — We have received the first fasciculus of Algæ Exsiccatæ Americæ Borealis, published by W. G. Farlow, C. L. Anderson, and D. C. Eaton. The present number comprises fifty species, principally from Key West and California, and is to be followed by other fasciculi, including the greater part of the marine species of the United States and some of the more interesting fresh-water algæ. The fasciculi will be of two different sizes: one of the size of Sullivant's Musci Cubenses, containing Florideæ and Chlorosporeæ, and the other of the size of ordinary herbarium sheets containing the larger Fuci, Laminariæ, etc. The price of the smaller sized fasciculus is $8.00, and of the larger, $12.00. In order to be able to include some of the rarer species in the series only a limited number of sets have been prepared, of which a few are offered for sale, and may be obtained by addressing Prof. W. G. Farlow, 6 Park Square, Boston.

SAXIFRAGA VIRGINIENSIS, *flore pleno.* — A prettier plant in its way than this double-flowered wild Saxifrage we have never seen. It was discovered by Mr. Joseph S. Adam, in Canaan, Connecticut, and is a perfectly spontaneous production, first noticed as a single plant, but is now multiplied into two or three, one of which is given to the Cambridge Botanic Garden. It is a tall specimen for the species; the stalk bearing seventy or eighty flowers; and each one bears as many petals, in a full rosette, a quarter inch in diameter, pure white. The inflorescence has the look of double-flowered *Spiræa filipendula*, or of a variety of *Cardamine pratensis*, which used to be in the gardens. The calyx is unchanged, an imperfect pistil is occasionally found in the centre; but the rest of the flower consists of petals only, in many ranks. We trust it may be preserved in cultivation. — A. GRAY.

BOTANICAL PAPERS IN RECENT PERIODICALS. — *Flora*, No. 5. Batalin. Mechanism of the Movements of Insect-Eating Plants (continued in numbers 7 and 9, but not yet finished). Dr. E. Duby, New Mosses. Dr. J. Müller, Lichens from Texas. No. 6. Dr. Scriba, A Notice of the Life of Dr. F. W. Schultz. F. Buchenau, The Cross-Section of the Capsule in the German *Junci* (with a plate giving the transverse sections of 18 species). No. 7. Dr. E. Stahl, An Explanation of Hymenialgonidia. No. 8. H. G. Holle, On the Activity of Assimilation in *Strelitzia reginæ*. (Not finished in 8 or 9.)

Botanische Zeitung. No. 11. Notice of Agardhi's *Species, Genera, et Ordines Algarum.* No. 12. R. Caspary. Remarks in regard to the Protective Sheath of Vascular Bundles. (Noticing objections to his use of the word protective-sheath (Schutzscheide.) No. 13. R. Caspary, On *Nymphæa Zanzibariensis*, n. sp. No. 14. Dr. Nowakowski, On Conjugation in some *Entomophthoræ.* No. 15. Otto Kuntze, Preliminary Report in regard to Cinchona. (Continued in No. 16.)